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GROUP LENDING, MORAL HAZARD, AND THE CREATION OF SOCIAL COLLATERAL

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IRIS Summary

This paper proposes a simple but quite general framework that is useful for analyzing the design of, and choice between, different financial intermediary structures and contract forms in a rural credit market setting. Special attention is given to the analysis of peermonitored group loans such as those used by the Grameen Bank of Bangladesh (and some private lenders in Chile), but the framework extends to show how this particular contract form may or may not be chosen over or alongside other possible financing strategies including the use of bank loans, intermediated loans from product market trader-lenders, informal moneylenders, and self-financing. In an empirical companion paper that analyzes findings from a fieldwork case study on the structure and operation of the competitive and deregulated market for rural finance in Chile I find a clear pattern of credit market fragmentation that is consistent with the model.

The paper contrasts two broad channels available to lender-intermediaries to solve or attenuate the frequently encountered problem of moral hazard in the use of borrowed funds: (1) collateral-based contracting designed to provide borrower's with indirect incentives to not take hidden actions that are harmful to the lender's interests; and (2) more direct strategies involving costly monitoring, helping, or other control activities in which a lender/intermediary attempts to directly lower the borrower's scope and gain from hidden actions.

The first type of lending strategy is most commonly associated with bank loans and other forms of (crop and non-crop) collateral based formal lending; while monitored loan strategies are employed by traders, contract farming firms, and informal moneylenders who lend against less collateral but charge higher (implicit) interest charges to compensate for their costly involvement in monitoring activities. Since traders and other monitoring lenders often not only use their own equity but also often on-lend or intermediate additional finance from less informed outside lenders, I model this intermediary structure as a principal-supervisor-agent problem. Intermediaries must lend sufficiently out of their own equity (or a cosigner must assume a large enough stake in the borrowers' project) to credibly commit to carrying out the monitoring activity on behalf of uninformed lenders. as described here and in the companion paper this sort of relation is often underpinned by or leads to the development of a system of bills of exchange.

Group lending is modeled as a two-task principal-multiagent problem in which each borrower in a group must be given incentives to choose unobserved actions both as an entrepreneur on his own financed production project and as a monitor of other borrowers. The analysis shows that 'social collateral' can be created in certain situations but that group loans will be offered by lenders and chosen by borrowers ahead of other forms of finance only where group members have a very substantial monitoring and enforcement advantage relative to outside monitoring intermediaries and where the correlation in project returns across borrowers is not too large. Other results not previously

discussed in the literature concerning group formation, collusion amongst borrowers, and the cost and benefits of group loans are also analyzed.

In summary the paper provides a simple but rich framework for analyzing the reach and limitations of private sector intermediary strategies that use interlinked terms and monitored lending as devices to create collateral substitutes in order to reach poorer borrowers. However, while many intermediary structures and innovative financial contract forms are able to go a long way to overcome many of the trading frictions created by information asymmetries and limited liability, such collateral substitute mechanisms are nonetheless often imperfect and costly alternatives to physical collateral. Ultimately, the development of financial markets to sustain efficient allocations in the real economy depends on the rising net worth of borrowers in the economy and on the quality and efficacy of the legal institutions that help support contract enforcement.

Group Lending, Moral Hazard, and the Creation of Social Collateral

by

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GROUP LENDING, MORAL HAZARD, AND THE CREATION OF SOCIAL COLLATERAL

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ABSTRACT. This paper analyzes joint liability loan contracts such as those used by the Grameen Bank of Bangladesh designed to provide incentives to a group of borrowers to monitor and help each other in ways that reduce the scope for moral hazard in the use of borrowed funds and hence lower loan collateral requirements. Building on a simpler model of monitored lending and financial intermediation that is of independent interest, group lending is modeled as a multitask principal-multiagent problem where each borrower must be given incentives to choose unobserved actions both as an entrepreneur on his own financed production project and as a monitor of other borrowers. The analysis shows that 'social collateral' can be created in certain situations but that group loans will be offered by lenders and chosen by borrowers ahead of other forms of finance only where group members have a very substantial monitoring and enforcement advantage relative to outside monitoring intermediaries and where the correlation in project returns across borrowers is not too large. Other results concerning group formation, collusion amongst borrowers, and the cost and benefits of group loans are discussed.

1. INTRODUCTION

A large part of all economic activity takes place within households, firms, partnerships, work teams and other types of group which are organized, at least in part, around the principle of social solidarity or by property relations that imply some form of profit sharing or joint liability. Members share in the fortunes and misfortunes of the overall enterprise rather than just being narrowly compensated for their individually measured performance or contribution to the project. Having traditionally been quicker to point to the difficulties and pitfalls inherent in team production rather than to it's possible virtues, economists have just recently begun to formally analyze some of the ways in which joint liability might be useful to motivate members of a group to help, pace and encourage, or to monitor, police, or pressure each other in ways that could raise the value of group production above what could be achieved under alternative individual contracting arrangements.

One important application of the concept of joint liability are group loan contracts designed to provide incentives for a group of borrowers to monitor and/or help each other in ways that reduce the scope for moral hazard in the use of borrowed funds and therefore lower the collateral that an outside lender would require relative to individually contracted loans. A great deal of recent practical and theoretical interest in this idea is due to the now famous and widely imitated experience of the Grameen Bank of Bangladesh.

This bank lends primarily to very poor and mostly female borrowers arranged into small borrowing circles. Each member of the group receives an individual loan only on condition that she accepts liability for the repayments of other members should they become unable or unwilling to repay.[1] Using this scheme, and despite the fact that it serves a population that would be deemed not-creditworthy by most conventional lenders, the bank has reached well over two million borrowers and reports enviable loan recovery rates in excess of 95%. Over time the bank has become increasingly self-sustaining and is now raises an important part of it's lending capital by mobilizing member savings and through it's own debt issues (Pitt and Khandker, 1995).

Unfortunately, the performance of group lending and credit cooperatives in other countries has been far more mixed, suggesting that the concept is by no means a universal, or one that can be easily transplanted or reproduced.[2] Additional theoretical research into the precise mechanisms that make group loans work, and further empirical studies of the particular social and economic circumstances where they have succeeded or failed is clearly needed if we are to explain these divergent experiences and to make what seems to be a good idea work better.[3]

[1]Borrowers are made liable not so much in the legal sense that the lender is entitled to seize property, but in the sense that if one or more members in a group defaults then the other members are punished by having their access to future loans curtailed. More detailed descriptions and empirical evaluations of the Grameen Bank of Bangladesh can be found in Hossain (1988) and Pitt and Khandker (1995).

[2]According to Pitt and Khandker (1995), group lending programs have been quite succesfully implemented in the Cameroon, Malawi, South Korea, Malaysia and Bangladesh but similar schemes have had problems in India, Egypt, Venezuela, Kenya and Lesotho. See Adams and Landman (1979) and Huppi and Feder (1990) for a review of the historical performance of group lending schemes in several countries. For an interesting historical perspective on the early importance of credit cooperatives in some parts of Europe and a failed transplant to Ireland, see Guinnane (1994).

[3]Although joint liability loans are often thought of as arrangements used primarily by non-governmental organizations and the not-for-profit cooperative sector, they are also used by private intermediaries. In Conning(1995) I describe a Chilean sugar beet contract farming that has used two person joint liability loan contracts for decades to extend substantial amounts of production credit to collateral poor sugar beet farmers. The Spanish term for these contracts is *avales cruzados* literally means crossed guarantors or crossed cosignors. The arrangement is clearly meant to act as a collateral substitute because farmers who borrow without a co-guarantor are required to offer

This paper contributes to that purpose by solving for the terms of an optimal joint liability contract as the solution to a multi-task, principal-multiagent problem with moral hazard and limited liability. Contract terms are chosen to provide each member in the group with incentives to choose actions both on his own production project and to monitor another borrower's project. Both actions are costly to undertake and can not be perfectly observed and are therefore subject to moral hazard. The optimal contract must satisfy the borrower's limited liability constraints, the investor's break even condition, must prevent the borrowers from colluding against the lender, and must encourage group members to take actions on their respective projects and also peer-monitor each other at minimum monitoring cost.

The group lending model is built as an extension to a simpler model of monitored lending and financial intermediation that is interesting in its own right. Using rural credit markets as an example, the model helps to explain and contrast financing strategies which mix and include: (1) collateral-based loans from banks, (2) monitored loans from product market traders, cosignors and other types of monitoring intermediaries who use their own capital to leverage additional outside finance, (3) loans from moneylenders and other informal sources who lend primarily out of their own equity, and (4) self-finance. By extending this simpler model to group lending I am able to arrive at several predictions concerning when group contracts will be offered and chosen over separate individual-based financial intermediation strategies.

The main result of the paper is that "social collateral" to replace missing physical collateral can be created through group loans, but only under particular circumstances. For a common monitoring technology, group loans involve much more monitoring than simpler one sided cosignor arrangements or intermediary loans. This is because group borrowers must in effect meet collateral requirements not just as borrowers but also as monitors (i.e. as monitors they must be able to assume a larger and larger liability in each other's project). To credibly lower the collateral requirements on a loan to the level of their available collateral assets, group borrowers must, through sufficiently intensified peer-monitoring, bring down the collateral requirement on each other's production projects enough below their available collateral asset levels to meet the rising liability requirement that their activity as monitors demands. For this reason, group loans will only be chosen over other sources of finance when group members have a decided cost advantage in monitoring and sanctioning each other relative to outside lenders and intermediaries. Borrowers will prefer to join groups where the returns to their projects are not too correlated for reasons quite apart from conventionally defined risk sharing.

The analysis serves to highlight a point that has often been neglected in theoretical analysis and empirical evaluations: group participation is a costly activity likely to affect borrowers' choices between group loan and simpler intermediated or collateral

physical guarantees instead.

based loans, and other activities. Pitt and Khandler summarized the point well in their empirical evaluation of the Grameen Bank and other group loan programs when they stated: "participation is costly, as group formation, training, and other group activities are time consuming and involve opportunity costs of time spent in group based activities ... [I]f there were not monitoring of the use of borrowed funds and group responsibility and decision making in the lending program, individuals would likely want to borrow much more than they actually do."

The rest of the paper is organized as follows. Section 2 briefly reviews the relevant literature on group contracting and monitored lending and highlights the contribution of this paper. Section 3 sets up a model of monitored lending where an intermediary lender or loan cosignor monitors a borrower on behalf of an uninformed outside lender. The intermediary must herself become a lender in the borrower's project or acquire a minimum liability stake as a cosignor in order to signal her commitment to implementing the unobservable monitoring activity. The model suggests why and how even highly competitive lending markets may fragment or segment in the sense that borrowers who are identical but for their initial asset holdings will obtain different levels of access to four different types of financing regimes ranging from collateral based bank lending, through two types of monitored lending, to exclusion. Section 4 extends the logic of this simpler model to a two person joint liability group loan arrangement, explains the structure and mechanism of the optimal contract, and presents several results concerning when group loans might be offered and preferred over the individual lending alternatives of the previous section. Section 5 concludes.

2. Previous Literature

This paper brings together in a simple model two different strands in the recent literature on agency contracting: a growing literature on monitored lending and financial contracting which explicitly incorporates limited liability constraints and assumes that monitoring is costly and imperfect but which has to date focused on hiearchical rather than group based incentive structures, and a recent theoretical literature on principal-multi-agent analysis which focuses on group contacting but which has mostly assumed that monitoring and enforcement within the group is perfect and costless and/or has ignored the role of limited liability constraints.

The monitored lending literature has examined situations where an intermediary lender or cosignor acts as delegated monitor of a borrower on behalf of other less informed investors. Banerjee et al (1994) employed this idea to model aspects of the operation of a credit cooperative. Holmstrom and Tirole (1994) and Hoshi et al. (1992) used a model with a similar structure and interpret the monitor to be an intermediary lender who puts some of her own capital at risk in the borrower's project. The model of section 2 below captures the essence of these arguments and presents some new implications.[4]

While these authors identify important mechanisms, these papers do not address what is perhaps the most interesting question about group loans: whether a group of poor borrowers, without the presence of a rich outside monitoring intermediary or cosignor patron to bear liability for their loans, can through the design of a group contract mechanism create "social collateral" that in a sense allows them to literally lift themselves up by their own bootstraps. To get answers to this question requires extending the simpler principal-supervisor-agent structures used in these other models to a multi-task principal-multiagent structure.

On the other hand, most of the vast literature on groups has taken joint or team production as *exogenously* given by natural or technological externalities and then points at the free rider problem and other drawbacks to team production that arise when the marginal contribution of each member to production is unobservable (e.g. Olsen, 1965; Cornes and Sandler, 1986; Holmstrom, 1982). A more recent theoretical literature focuses on how contract terms might be chosen by a principal to provide incentives for team production and other interactions among agents to arise *endogenously*, even in situations where agents are not linked through the production function.[5]

A very relevant application from this last literature to the problem of group loans is the paper by Stiglitz (1990). He uses a model with moral hazard and limited liability to argue that joint liability group loans can allow borrowers to obtain larger loans through group based programs than through individual loans. While his analysis is suggestive, Stiglitz' results, like several other papers in this literature, are limited somewhat by the fact that he proceeds under the *full side-contract assumption* that monitoring within the group is achieved perfectly and without cost (Itoh, 1993; Tirole, 1990) . Under this assumption the group in effect acts like a single individual or syndicate coordinating action levels in response to the principal's contract. Since the

[4]Diamond (1984) introduced the notion of an intermediary lender acting as a delegated monitor for other less informed lenders. Many of the same mechanisms used in this financial monitoring literature also formed the basis for results in an earlier literature on interlinked agrarian contracts (e.g. Braverman and Srinivasan, 1980, Braverman and Stiglitz, 1982 and as far back as Bhaduri, 1973) and the more general literature on multi-task agency analysis (e.g. Holmstrom and Milgrom, 1991).

[5]See for example Arnott and Stiglitz (1991), Holmstrom and Milgrom (1990), Itoh (1993,1992), Mookerjee(1984); Stiglitz (1990, 1994), Tirole(1990), Varian (1990) and others. The main result in this literature is that the principal can be made better off by allowing the agents to side-contract on contingencies which are not contractible to the principal. The principal can implement actions at lower cost when the agent's can insure each other over contingencies the principal cannot observe, or when the principal can take advantage of the fact that the agents can perfectly monitor and hence coordinate their effort choices. On the other hand, the principal can only be made worse off when agents are able to form coalitions and side trades which recontract on variables that the principal could have included in her original contract.

new supra-individual or syndicate now owns two projects with imperfectly correlated returns which yield a safer joint return compared to ownership of either individual project separately. The average collateral requirement on group loans are therefore lower because safer projects in general require lower collateral requirements because of a well known diversification effect (Diamond, 1984).

The full side-contract assumption sweeps under the rug many interesting questions about group formation and interaction. In the model in this paper, the ability of a group of borrowers to create 'social collateral' will ultimately also rest on a diversification argument but the argument is more subtle and acts at the level of each individual borrower. By explicitly considering the costs of monitoring within the group, the analysis uncovers trade-offs not previously analyzed. For instance, where Stiglitz' diversification argument would suggest that a group of agents with sufficiently uncorrelated project returns would always be offered and choose group contracts over individualistic loan contracts, I show that the required costs of monitoring rise faster within a group than in one sided monitored arrangements, so the choice between group loans and other arrangements will in general depend on the average net worth of the borrowers involved and the size of the loans as well.

The model I analyze is perhaps most similar in structure to the principal-multiagent problem analyzed by Hideshi Itoh (1991). There are several important differences however: where Itoh focuses on the classic trade-off between risk sharing and incentives, I am interested in the trade-off between incentives and limited liability required of an analysis of financial contracts. Perhaps the most interesting contrast is that where Itoh arrives at the strong negative result that incentives for agents to peer-monitor (offer "helping hands" in his language) can only be created in the limiting and somewhat unrealistic case where "the agent's marginal disutility with regard to helping effort is zero at zero help (p. 613)," I find that incentives can be provided under a wider set of circumstances. As discussed below, this added scope for peer-monitoring arises in large part because of differences in the assumed sequence of actions in the two models.

Finally, the approach to group lending examined here should be contrasted to the recently published paper by Besley and Coate (1995). These authors examine the related but different question of how joint liability contracts can be used to create incentives for group members to apply social penalties on each other to alter each member's *willingness* to repay a loan *after* the project outcomes have been observed (ex-post moral hazard or costly state verification). The focus here by contrast is to find an incentive structure that deters hidden actions *before* outcomes are observed and which therefore affect the borrower's *ability* to repay (ex-ante moral hazard). Both issues are important in lending markets in developing countries and would be considered together in a more complete analysis.

3. The model

This section introduces a principal-supervisor-agent structure to study the relationship between an uninformed outside lender, a monitoring intermediary, and a borrower. Building on this model the next section extends the analysis to group lending. I will use the simplest possible model to make the main points and employ examples and lending categories from rural credit markets to motivate and illustrate the analysis.[6]

Consider a borrower who has access to a crop production project that requires a non-recoverable lump sum investment I. Actual project outcomes are stochastic and determined both by exogenous factors such as the weather and by actions and input choices that the borrower can control. The borrower's choices might include for instance decisions on how the investment funds are to be used and the quantity and quality of labor effort and other inputs in production. I limit attention to projects that involve only two possible production action choices. When the producer chooses the "high" action (or input bundle) the project is expected to yield a successful harvest outcome x_s with probability $\overline{\pi}$ and a failure harvest outcome x_f with probability $(1-\overline{\pi})$. If the borrower instead chooses the low action, the probabilities are $\underline{\pi}$ and $(1-\underline{\pi})$ respectively, with $\overline{\pi} > \underline{\pi} > 0$.

By choosing the lower action $\underline{\pi}$ the producer is assumed to be able to divert resources or apply less labor effort to the financed project and obtain a private benefit of value $B(c)$. This private benefit, which can also be described as the borrower's opportunity cost of being diligent, is assumed to depend on c the amount of resources which the lender spends on monitoring and sanctioning the borrower's activities. The "monitoring technology" defined by the function $B(c)$ is described in more detail below. A "low" action might for instance involve the borrower secretly diverting a portion of the borrowed funds from the financed project into other consumption or production activities which deliver a private benefit to the borrower but lower the expected value of the project returns from which a lender expects repayment. A problem of moral hazard arises because the borrower's action is unobserved by an outside lender or the enforcement authority and no action contingent financial contract can be verified or enforced.

There are two possible solutions to the moral hazard problem in this context: an indirect solution which involves structuring the returns a borrower obtains from the contract for each possible project outcome in such a way that the borrower has the incentive to choose the high action even though he is not directly observed, and a direct or monitoring solution. This second solution which is complimentary to the

[6]The model in this paper is informed by, and has helped to frame and interpret findings from a fieldwork case study of the market for rural credit that I conducted in Chile in 1994. Interested readers are refered to Conning (1995) for a more detailed description and empirical analysis of the many ways that monitored loans and other lending strategies are accomplished in practice.

first refers to the strategy of carrying out monitoring, sanctioning or helping activities aimed at modifying the private benefits that the borrower might stand to gain from different actions. Even when the borrower's action choices remain unobservable to the lender monitoring activities may have the effect of diminishing the severity of the moral hazard to be solved through an indirect contract mechanism. There are many ways monitoring strategies are pursued in practice. For example, in the context of rural lending, trader-lenders and contract farming firms[7] often take measures such as regularly visiting farm borrowers' in their fields during the course of the growing season, delivering credit advances in kind rather than as cash, and following strict loan delivery timelines where future loan disbursements are contingent upon interim performance reports. Each of these activities, which are evidently costly to the lender, appear to be clearly aimed at lowering the potential private benefits that borrower's might stand to gain from diverting credit resources to uses other than the financed project, and at detecting and threatening punishment should any diversions be discovered. A more positive, and complimentary, interpretation is that lenders visit farm borrowers to provide them with technical assistance and other forms of "help" that have the effect of lowering the borrower's cost of taking higher actions. I make the following reasonable assumption of the "monitoring technology" $B(c)$

Assumption 1: *The borrower's private benefits from taking the low action are given by $B(c)$ where $B_c < 0$ and $B_{cc} > 0$ and where c is the monitor's action or expense.*

This assumption states simply that the more the intermediary lender spends on monitoring and enforcement activities the lower will be the net private benefits the borrower might expect to obtain from the unobserved low action, but that there are diminishing returns to monitoring.[8] The monitoring (or helping) activity carried out by a monitor is therefore assumed to *complement* the other borrower's production activity in the sense that higher c lowers the marginal benefit to lower actions (or equivalently, raises the marginal benefit to higher actions). In order to highlight the problem caused by moral hazard more starkly, I assume that the high action project is always profitable while the low action project is not profitable even at zero monitoring:

$$E(x|\overline{\pi}) - I(1+\rho) \geq 0 > E(x|\underline{\pi}) - I(1+\rho) + B(0)$$

[7]Farm product traders and contract farming firms are intermediaries who contract to receive all or a portion of a farmer's expected produce at harvest in exchange for credit advances and other services such as technical assistance delivered earlier in the season. In many parts of the world tied credit of this sort is the main source of production finance for agriculture (Conning, 1995).

[8]Other shapes for the monitoring technology could also be admitted without altering the model's main predictions. For instance, an initial indivisibility (e.g. a lender incurs a fixed setup cost) would imply that monitoring only has effects if above a minimum threshold. One might also at first assume increasing ($B_{cc} < 0$) and then constant ($B_{cc} = 0$) economies before diminishing returns set in ($B_{cc} > 0$).

where $E(x|\overline{\pi}) = \overline{\pi} x_s + (1-\overline{\pi})x_f$ is the expected value of the project returns and $I(1+\rho)$ is the return that could be earned on the investment funds I had they been placed in a bank deposit instead of in crop production. It is clear from this inequality that a producer who uses his own investment resources I would never choose the low action project, and similarly that an outside investor will finance the borrower with a loan of size I, only if she could stipulate and be assured that the borrower will choose the high action.

There are two types of lenders on this market: uninformed lenders in the formal banking sector who rely exclusively on collateral-based loans, and monitoring intermediary lenders such as traders or informal moneylenders. This last group of intermediaries often owe their role as monitors to specific information and enforcement advantages they possess by virtue their close interactions with borrowers in other transactions and social spheres. Borrowers can obtain loans from both, either, or neither source of finance depending on accessibility and choice.

The contract design problem consists on deciding on how to divide the available claims from each harvest outcome x_i between returns to the borrower s_i, returns to an uninformed lender ρ_i and returns w_i to the monitoring intermediary lender so as to implement the high action at minimum monitoring expense c. The sequence of actions is as follows. First the parties agree to the terms of a contract and the lender(s) deliver their loans to the borrower (I^m and/or I^u). If it is to be a monitoring contract, at the start of the production cycle the monitor then commits to a monitoring strategy that involves resources c, following which the borrower chooses his unobserved production action π. In the final stage uncertainty is resolved and the claims to the observed project outcome is divided between the parties according to the terms of the contract. Assuming free entry into both the uninformed and monitored lending activities, the optimal contract $\{w_i, s_i\}$ for a borrower with collateralizable assets A is the solution to the following program:

$$\max_{c,\, w_i\,,\, s_i} E(s_i|\overline{\pi})$$

$$E(R_i|\overline{\pi}) \geq I^u(1+\rho) \tag{1}$$

$$E(w_i|\overline{\pi}) - c \geq I^m(1+\rho) \tag{2}$$

$$E(s_i|\overline{\pi}) \geq E(s_i|\underline{\pi}) + B(c) \tag{3}$$

$$E(w_i|\overline{\pi}) - c \geq E(w_i|\underline{\pi}) \tag{4}$$

$$s_i \geq -A \qquad i = 1,2 \tag{5}$$

$$I^m + I^u = I, \quad I^m \geq 0, \quad I^u \geq 0, \tag{6}$$

$$c \geq 0, \quad x_i = R_i + w_i + s_i$$

where (1) is the investor's participation constraint or break even condition, (2) is the intermediary's break even condition, (3) is the borrower's incentive compatibility constraint, (4) is the intermediary's monitoring incentive compatibility constraint, and (5) are the borrower's limited liability constraints. The expressions in (6) are adding up and non-negativity constraints.

The borrower's limited liability constraint expresses the fact that total repayments from the borrower to the lenders following any given project outcome x_i cannot exceed value of that outcome plus all of the borrower's available collateral assets A, so $R_i + w_i \leq x_i + A$. Inequality (5) is then obtained by noting that $R_i + w_i = x_i - s_i$.

The uninformed lender's participation constraint requires that this lender earn at least as much from expected repayments as she could earn from leaving the same investment funds I^u in the bank. Similarly, the intermediary's participation constraint (2) states that the expected value of repayments w_i to an intermediary who lends amount I^m and monitors at optimal intensity c must at least equal what the intermediary could have earned from the bank net of the monitoring expense.

For later use note that the borrower's incentive compatibility constraint can be rearranged to give the more compact expression:

$$s_s - s_f \geq \frac{B(c)}{\Delta\pi}$$

where $\Delta\pi = (\overline{\pi} - \underline{\pi})$. It is evident from this expression that an optimal contract requires that the borrower earn more for successful outcomes than for failures so as to provide the borrower with an incentive to raise the probability of success by choosing higher actions.

If the contract is to involve some monitoring, and if resources are to be leveraged from an outside lender, the intermediary will also have an incentive constraint because her monitoring actions cannot be observed by the outsider lender. Since the intermediary's monitoring activity lowers the borrower's private benefit $B(c)$ at expense c and this in turn raises the borrower's incentive to choose the high action, raising the probability of the project being a success, the contract should reward the intermediary for the borrower's successes and punish him for the failures. This can be seen clearly when the intermediary's incentive compatibility constraint is rewritten as $w_s - w_f \geq \frac{c}{\Delta\pi}$. Like the borrower, an intermediary will be required to post bond or collateral: to have a large enough stake in the project to not want to see it fail. In the intermediary's case this bond or collateral can be interpreted as a loan the intermediary invests up front in the borrower's project. Alternatively the monitor can be interpreted to be a cosignor on the loan and the bond is equal to the amount of the liability the cosignor assumes in the borrower's project.

Four possible contractual forms or lending regimes emerge from the optimization problem. Which loan type is optimal or best matched to a particular type of borrower will depend on the level of collateral assets A that borrower has to offer, as stated in the following proposition:

Proposition 3.1. *Define the Minimum Collateral Requirement function $\underline{A}(c)$ over the domain $[0, \infty)$*

$$\underline{A}(c) = \overline{\pi}\frac{B(c)}{\Delta\pi} - E(x|\overline{\pi}) + I(1+\rho) + c \tag{7}$$

and define the cutoff level $\overline{c}$ from the relation $\overline{\pi}\frac{B_c(\overline{c})}{\Delta\pi} = -1$ and $\widehat{c} = \frac{I(1+\rho)}{\overline{\pi}}$. The Optimum Monitoring Intensity $c = c(A)$ is defined implicitly by $A = \underline{A}(c)$ over the range $[0, \overline{c}]$. Borrowers will be matched to different loan types according to their initial level of collateral assets as follows:

Loan Type	Collateral Assets	Loan Amounts
Loans from Uninformed Lenders *(e.g. Banks and other collateral based lenders)*	$A > \underline{A}(0)$	$(I^u = I\,,\, I^m = 0)$
Intermediated Loans *(e.g. Traders that leverage additional finance from Bank)*	$\underline{A}(0) > A > \underline{A}(\widehat{c})$	$(I^u \geq 0\,,\, I^m > 0)$
Directly Monitored Loans *(e.g. Traders or Moneylenders who lend from own equity)*	$\underline{A}(\widehat{c}) > A > \underline{A}(\overline{c})$	$(I^u = 0\,,\, I^m = I)$
Excluded from loan market *(e.g. borrower self-finances or abandons production)*	$\underline{A}(\overline{c}) > A$	$(I^u = 0\,,\, I^m = 0)$

where I^m is the loan required from the monitoring intermediary and is given by $I^m(1+\rho) = \overline{\pi}\frac{c(A)}{\Delta\pi} - c(A)$ over the asset range $A \in [\underline{A}(\overline{c}), \underline{A}(0))$ and as indicated in the table otherwise.

These results can be understood as follows. Consider first the contract offered by an uninformed lender, such as a bank, without the presence of an additional intermediary lender. Since there is no intermediary involved we can drop (2) and (4) and set $w_f = w_s = c = 0$. From the incentive compatibility constraint (3) and the borrower's (implicit) participation constraint it is clear that if collateral is to be required at all, it will be in the failure state. It is also evident that when collateral use is at a minimum the borrower's incentive compatibility constraint (3) must bind because this makes the failure repayment level $R_f = x_f - s_f$ as low as feasible (and s_f as large as feasible). The binding incentive compatibility constraint gives us the relation $s_s = s_f + \frac{B(0)}{\Delta\pi}$ and therefore $E(s_i|\overline{\pi}) = s_f + \overline{\pi}\frac{B(0)}{\Delta\pi}$. This last term is the minimum expected value of returns that must be left with the borrower if the incentive compatibility constraint is to hold and the borrower is to pay out no more than the full project outcome and available collateral in the failure state.

Substituting this into the investor's break even condition yields:

$$E(R_i|\overline{\pi}) = E(x|\overline{\pi}) - s_f - \overline{\pi}\frac{B(0)}{\Delta\pi} \geq I(1+\rho)$$

The lowest repayment $R_f = x_f - s_f$ such that the above constraint holds exactly and the investor just breaks even defines a minimum cutoff $\underline{A}(0) = -\ s_f$. This value, $A(0)$, is the minimum collateral requirement for an uninformed (e.g. bank) loan and is given by:

$$\underline{A}(0) = \overline{\pi}\frac{B(0)}{\Delta\pi} - E(x|\overline{\pi}) + I(1+\rho) \tag{8}$$

Borrowers with assets $A \geq \underline{A}(0)$ will have access to loans that require minimum collateral requirements of exactly $\underline{A}(0)$ and will earn $E(s_i|\overline{\pi}) = -\underline{A}(0) + \overline{\pi}\frac{B(0)}{\Delta\pi} = E(x|\overline{\pi}) - I(1+\rho)$ in expected value, the expected project outcome net of the minimum expected repayments required for the investor to participate. The cost of funds to the borrower is therefore ρ, exactly the lender's opportunity cost of funds, or the lowest market rate.

Borrowers who do not have sufficient assets to meet these requirements will be excluded from pure-collateral based loans but may still obtain finance through more expensive monitored loans. To consider these cases, note that under the free entry assumption intermediary profits are driven to zero so the intermediary's break even constraint should hold as an equality. Substituting solution $w_f = 0$, $w_s = \frac{c}{\Delta\pi}$ (which can be seen to satisfy the intermediary's monitoring incentive compatibility constraint (4)) into the intermediary's binding participation constraint (2) yields an expression for the size of the minimum required intermediary loan for any level of monitoring intensity:

$$I^m(1+\rho) = \overline{\pi}\frac{c}{\Delta\pi} - c \tag{9}$$

The intermediary lender is made liable for the borrower's actions because she stands to lose $I^m(1+\rho) + c$, the full value of her investment plus the monitoring expense c when the project fails, but earns a positive return $\left[\frac{c}{\Delta\pi} - I^m(1+\rho) + c\right]$ when the project succeeds, so as to just break even on the investment. The amount of this liability is just enough to make the intermediary to monitor the borrower sufficiently to take the high action. To solve for the minimum collateral requirement when there is a monitor involved, simply substitute (9) and $E(s_i|\overline{\pi}) = s_f + \frac{B(c)}{\Delta\pi}$ (from the borrower's incentive compatibility constraint) into the investor's participation constraint (1), and rearrange terms as before to obtain:

$$\underline{A}(c) = \overline{\pi}\frac{B(c)}{\Delta\pi} - E(x|\overline{\pi}) + I(1+\rho) + c$$

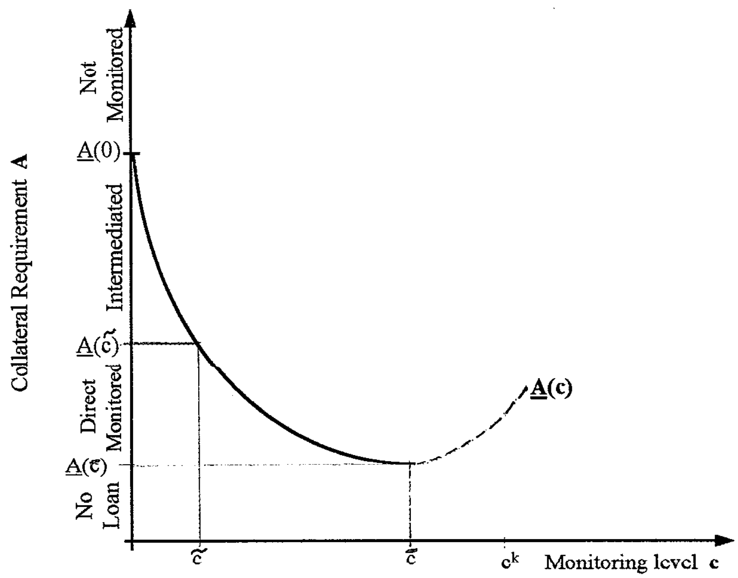


FIGURE 1. Collateral Requirement and Monitoring Intensity

The minimum collateral requirement on an uninformed loan in (8) is therefore just a special case of this more general collateral hurdle with monitoring intensity set at zero.

Whether or not monitoring lowers the minimum collateral requirement on a loan will depend on the nature the monitoring technology. There are two effects. On the one hand monitoring lowers the borrower's private benefits from side activities, relaxing the borrower's incentive compatibility constraint, lowering the enforcement rent that must be left with the borrower by $\overline{\pi}\frac{B_c(c)}{\Delta\pi}$ and lowering the collateral requirement. On the other hand, monitoring is a costly activity which must be paid for, so expected total project surplus is reduced which raises the collateral requirement. If we assume that $\overline{\pi}\frac{B_c(0)}{\Delta\pi} > -1$ then the first dollar spent on monitoring lowers the collateral hurdle. Because of diminishing returns to monitoring however, beyond some monitoring intensity $\overline{c}$, the marginal benefit from an extra dollar spent will not compensate the marginal cost ($\overline{c}$ is given by $\overline{\pi}\frac{B_c(\overline{c})}{\Delta\pi} = -1$) so no further monitoring is worthwhile. Figure 1 shows how the minimum collateral requirement might fall over the range $(0, \overline{c})$ and rise thereafter.

Corollary 3.2. *Monitored lending is more expensive than uninformed lending. The implicit interest rate on loans is non-increasing in the given by* $\rho(A) = \rho + \frac{c(A)}{I}$, *with* $\rho'(A) < 0$ *over the range* $\underline{A}(0) \leq A \leq \underline{A}(\overline{c})$.

The borrower's return on a monitored contract is easily calculated to be $E(s_i|\overline{\pi}) = E(x|\overline{\pi}) - I(1+\rho) - c$. Monitored lending is therefore more expensive than uninformed lending, so only borrowers with assets below $\underline{A}(0)$ excluded from direct bank loans would consider this form of lending.

The optimum monitoring intensity c still remains to be determined. It is clear however that monitored borrowers will choose loans that involve only just as much monitoring as needed to lower the collateral requirement to the borrower's available asset level A. The optimal level of monitoring is therefore that level at which $A = \underline{A}(c)$. Call this level $c(A) = \underline{A}^{-1}(A)$. The optimal monitoring level $c(A)$ is higher for borrowers with lower collateral assets so it follows that poorer borrowers will use a larger proportion of monitored lending I^m as drawn in figure 2. Because poorer borrowers are more heavily monitored and monitoring is expensive, poorer borrowers pay a higher implicit rate on borrowed funds. From $E(s_i|\overline{\pi}) = E(x|\overline{\pi}) - I(1+\rho) - c(A)$ the implicit interest rate on a monitored loan is calculated as $\rho(A) = \rho + \frac{c(A)}{I}$ which is non-increasing in borrower's collateral holdings.

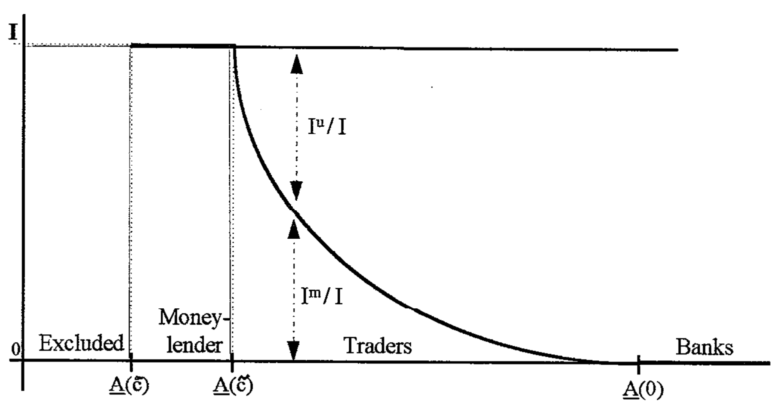


FIGURE 2. Proportion of monitored finance in total borrowing.

By lending I^m the intermediary establishes a stake in the borrower's project which provides her with the incentive to monitor, and it also lowers the size of the remaining investment $I^u = I - I^m$ required to have the project fully funded. An uninformed lender will be willing to step in and make the remaining investment I^u precisely because the investment I^m signals that the project is being monitored. This is the sense in which the monitoring lender is also an intermediary: she facilitates or intermediates funding from other less informed sources.

When monitoring intensity has reached a point $\widehat{c}$ defined by $I^m(1+\rho) = \overline{\pi}\frac{\widehat{c}}{\Delta\pi} - \widehat{c} - I(1+\rho)$ the loan requires so much monitoring that the intermediary's required participation makes up the full required lump sum investment I. From this point on there is no outside investor left to persuade, and the monitoring lender will be lending entirely out of her own equity. Monitoring intensity eventually reaches level $\overline{c}$, beyond which further monitoring becomes counterproductive. This defines an absolute minimum collateral requirement $\underline{A}(\overline{c})$, below which borrowers will be excluded from the loan market.[9] Several studies have characterized informal moneylenders precisely in these terms they lend primarily out of own equity, they monitor and screen borrowers heavily and often at substantial cost, and they charge high interest rates (Aleem, 1994; Bell, 1994). Venture capital lending in many developed countries may have some similar attributes.

4. Group Lending

In a peer-monitored group loan each member must be given incentives to act in two different roles: first as a borrower responsible for choosing action level π on his financed production project and second as a monitor deciding on the monitoring intensity c with which to oversee and sanction the actions of other members in the group. The structure of the problem is therefore that of multi-task principal-multi-agent problem.

I focus the analysis on a symmetric two member group. Using this symmetry, and to economize on notation I will describe the contract below almost exclusively from the perspective of borrower one. Where ambiguity could arise I will use superscripts to denote variables corresponding to each borrower. Thus x_i^k means a project outcome i for borrower k, and so on. Denote by s_{ij} the return to borrower one following an outcome x_i^1 on his own project and an outcome of x_j^2 on borrower two's project. Since there are four possible joint outcomes the reward schedule for each borrower is given by a four dimensional vector $(s_{ss}, s_{sf}, s_{fs}, s_{ff})$.

The joint probability of an output pair (x_i^1, x_j^2) induced by the production functions when the action pair π^1, π^2 is chosen will be denoted $\Pi_{ij}(\pi^1, \pi^2)$. I will assume that there are no production externalities, so each borrower's production project is affected in a direct technological sense only by his own action level. Initially, I also assume that the outcomes from the two borrower's projects are statistically independent, so $\Pi_{ij}(\pi^1, \pi^2) = \pi_i^1 \cdot \pi_j^2$ for each (i, j) and (π^1, π^2). These assumptions serve to isolate

[9] I've assumed that the farmer's own participation constraint does not bind before monitoring level $\overline{c}$ is reached. If the farmer's reservation utility is given by K, then his binding participation constraint $E(s_i|a_h) = E(x_i|a_h) - I(1+r) - c = K$ defines a cutoff level $c^k = E(x_i|a_h) - I(1+r) - K$. I assume therefore that $\overline{c} \leq c^k$.

and distinguish the mechanism analyzed here for why interdependent repayment rules may be optimal from the explanations suggested by joint production and relative performance evaluation (RPE). Later in this section and in the concluding remarks I discuss how the results change as the statistical independence assumption is relaxed. Given these assumptions, the joint probabilities can be written out simply. For example, $\Pi_{sf}(\overline{\pi}, \underline{\pi}) = \overline{\pi} \cdot (1 - \underline{\pi})$

Just as the intermediary monitor was unable to, group members cannot observe each other's production project actions perfectly. As before the monitoring function $B(c)$ described in assumption 1 captures the idea that by spending time and resources worth c on monitoring and sanctioning (and/or helping) activities monitors cum borrowers may be able to lower the private value that the other borrowers in the group stand to gain from taking the low actions. In this context c might measure for instance the amount of time and resources members devote to attending meetings, visiting each other and socializing, hiring a group supervisor, pressuring each other to behave responsibly, etc. Another simple but reasonable interpretation is that the private gain a borrower stands to gain may be lower simply because of the fact that he is more likely to feel guilty or bad or to face credible retaliation by cheating on a friend or community member who has shown a willingness to become liable and spend time and energy on the group project, than he is by cheating on a faceless bank clerk or government bureaucrat to whom he owes no particular loyalty. This last argument clearly appeals to social interactions which are outside the realm of what can be easily modeled in a one period model and to what has at times been called the "moral economy" of the community (Scott, 1976).[10]

The loan contracting problem can be thought as a mechanism design problem. The terms of the contract s_{ij} determine the structure of a game in monitoring intensities and action choices played between the two borrowers. The offered contract must satisfy incentive compatibility constraints, the limited liability constraints $s_{ij} \geq -A$ and the investor's participation constraint. The desired outcome is to induce each borrower to choose an equilibrium monitoring intensity c at a first stage of the game which then sustains or implements the desired high action choice $\overline{\pi}$ as the equilibrium outcome of the final stage of the game. Since monitoring is an expensive activity, an optimal contract will clearly set c as low as possible to sustain incentives.

Figure 3 depicts the game played between two borrowers receiving contract $\{s_{ij}\}$.

[10]This interpretation is consistent with several descriptions of way group lending schemes work. Descriptions of the Grameen Bank scheme highlight the intense loyalty and at times near-religious fervor that is generated and expected from group members. Heavy social presure is placed on members to attend meetings in which they are regularly made to make solemn oaths to one another (Pitt, 1995). Group members are made to internalize feelings of remorse, guilt or shame for taking actions that might hurt others and to feel pride for actions that help.

Conning (1993) discusses how recent economic models of contracting may contribute to a better understanding of the so called moral economy.

At the first stage the borrowers play a game in monitoring intensities.[11] Given a contract, each possible monitoring intensity pair (c^1, c^2) chosen at this first stage determines the payoff structure of a subgame in actions at the second stage. This subgame will be denoted $\zeta(c^1, c^2)$. The equilibrium outcomes and payoffs for each of these subgames must be calculated before we can calculate the payoffs and equilibrium outcome of the first game in monitoring intensities. We will therefore be searching for a subgame perfect Nash equilibria (SPNE) of the two stage game. Figure 4 shows the payoffs to any particular subgame in action pairs while the bottom of figure 4 indicates four such subgames $\zeta(c,c), \zeta(0,c), \zeta(0,c), \zeta(0,0)$ that will be important in establishing the equilibrium and disagreement payoffs in the overall game.

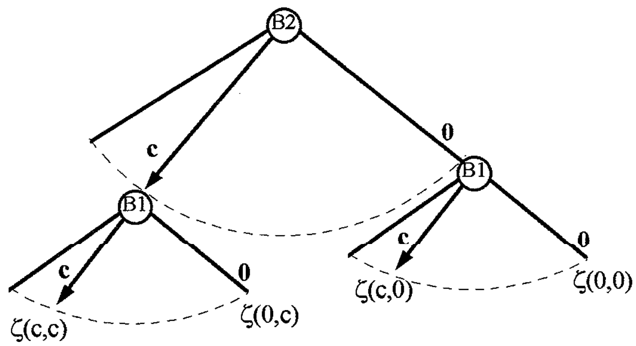


FIGURE 3. Game Tree (first stage in monitoring intensities c)

For contract s the expected return to borrower one from his production activity (which may include repayments required to cover the other borrower's failure) is denoted $E(s_{ij}|\pi^1, \pi^2)$. For example

$$E(s_{ij}|\underline{\pi}, \overline{\pi}) = \underline{\pi}[\overline{\pi}\, s_{ss} + (1-\overline{\pi})\, s_{sf}] + (1-\underline{\pi})\,[\overline{\pi} s_{fs} + (1-\overline{\pi}) s_{ff}]$$

would denote the expected payoff for borrower one (two) when borrower one (two) chooses the high action choice borrower two (one) chooses the low action choice, and so on for the other action pairs. The total final payoff to borrower one must however subtract the costs of monitoring and add in any private benefits that might have been captured by choosing the low but privately beneficial action level on his production project. For example $E(s_{ij}|\underline{\pi}, \overline{\pi}) - c^1 + B(c^2)$ is the final payoff just described when

[11] In the figure B1 indicates borrower one, B2 is borrower two, and the dashed arched line indicates that the monitoring intensities c are chosen simultaneouslyand from a continuum $(0, \overline{c}^g)$.

$\zeta(c^1, c^2)$:

		Borrower Two $\bar{\pi}$	**Borrower Two** $\underline{\pi}$
Borrower One	$\bar{\pi}$	$E(s_{ij} \mid \bar{\pi}, \bar{\pi}) - c^1$ $E(s_{ij} \mid \bar{\pi}, \bar{\pi}) - c^2$	$E(s_{ij} \mid \bar{\pi}, \underline{\pi}) - c^1$ $E(s_{ij} \mid \bar{\pi}, \underline{\pi}) - c^2 + B(c^1)$
Borrower One	$\underline{\pi}$	$E(s_{ij} \mid \underline{\pi}, \bar{\pi}) - c^1 + B(c^2)$ $E(s_{ij} \mid \underline{\pi}, \bar{\pi}) - c^2$	$E(s_{ij} \mid \underline{\pi}, \underline{\pi}) - c^1 + B(c^2)$ $E(s_{ij} \mid \underline{\pi}, \underline{\pi}) - c^2 + B(c^1)$

FIGURE 4. Payoffs in subgame $\zeta(c^1, c^2)$

borrower one (two) monitors at cost c^1 and borrower two (one) monitors borrower one (two) at intensity c^2.

The main results of the paper can be summarized in the following proposition which will be proved and explained in the text below and with the aid of figures 5 through 7.

Proposition 4.1. *If $B_c(0) < -\frac{1}{\overline{\pi}}$, then a symmetric joint liability loan contract s_{ij} will be available to borrowers with assets in the range $A \in (\underline{A}(0), \max[\underline{A}^g(\overline{c}^g), \underline{\underline{A}}^g(c)])$. The contract induces a monitoring intensity $c(A)$ defined implicitly by $A = \underline{A}^g(c)$ where*

$$\underline{A}^g(c) = \overline{\pi}\left[\frac{B(c)+c}{\Delta\pi}\right] - E(x|\overline{\pi}) + I(1+\rho) \tag{10}$$

and

$$\underline{\underline{A}}^g(c) = \overline{\pi}\left[\frac{B(0)+c}{\overline{\pi}^2 - \underline{\pi}^2}\right] - E(x|\overline{\pi}) + I(1+\rho) \tag{11}$$

The optimal contract s_{ij} will have the following simple structure $s_{ss} = -\underline{A}^g(c) + Z(c)$, $s_{sf} = s_{fs} = s_{ff} = -\underline{A}^g(c)$, where $\underline{A}^g(c)$ is defined as above and $Z(c) = \frac{B(c)+c}{\overline{\pi}\Delta\pi}$

The details of the proof are in the appendix but substantial economic intuition for the result can be obtained by examining the characteristics of the proposed solution.

Suppose for a moment that an outside intermediary lender has access to exactly the same monitoring technology $B(c)$ that is available to the borrowers cum monitors in a group. How does the minimum collateral requirement on a group loan $\underline{A}^g(c)$ compare to requirement on individual loans $\underline{A}(c)$ (defined by (7)) that each member might instead establish with an outside lender? A little rearranging demonstrates that the relationship between the two collateral requirements is given by:

$$\underline{A}^g(c) = \underline{A}(c) + \overline{\pi}\frac{c}{\Delta\pi} - c$$

Notice that, for a contract requiring monitoring intensity c, the intermediary monitor in the last section was required to make a minimum investment of $I^m(1+\rho) = \overline{\pi}\frac{c}{\Delta\pi} - c$, exactly the amount expressed in the last two terms on the right hand side. This was the size of the minimum stake or liability an intermediary lender or cosignor had to have to be a credible monitor in the eyes of an outside investor. We therefore have

$$\underline{A}^g(c) = \underline{A}(c) + I^m(1+\rho) \tag{12}$$

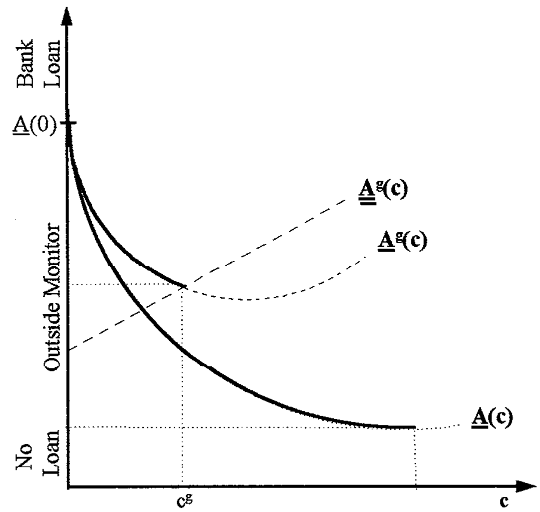
This expression has a very intuitive interpretation: since each member in the group is acting in two capacities – both as a borrower and as a monitor, and both of these activities are subject to moral hazard, a contract will require that the borrower cum monitor post collateral for both activities. This immediately leads to the following corollary observation:

Corollary 4.2. *A peer-monitored loan will be preferred over an outside intermediary or cosignor loan only if the group monitoring technology $B^g(c)$ offers a decided advantage over the outside intermediary's monitoring technology $B(c)$. More specifically, there will be gains to using a group loan when the group monitoring technology $B^g(c)$ satisfies $B^g(c) < B(c) - \frac{\underline{\pi}}{\overline{\pi}}c$*

The result can be easily seen by examining figure 5[12]. Since $\frac{\overline{\pi}}{\Delta\pi} > 1$ under the maintained assumption that $\overline{\pi} > \underline{\pi} > 0$, if the members of the group and the outside intermediary have the same monitoring technology $B^g(c) = B(c)$, then from expression (12) $\underline{A}^g(c) > \underline{A}(c)$ at any level of monitoring. Put differently, for any level of available collateral assets a peer-monitored loan will always involve more monitoring and be more expensive to the borrower, unless the group members can monitor at a much lower cost than the outside intermediary.

Group loans involve more monitoring than intermediary loans because group members must monitor each other more heavily in order to push the collateral requirement on their production loan ($A(c)$ in expression (12) above) far enough below their

[12]The dashed diagonal line in the figure and which restricts the available group loan contracts arises from the "no collusion" constraint $\underline{\underline{A}}^g(c)$.



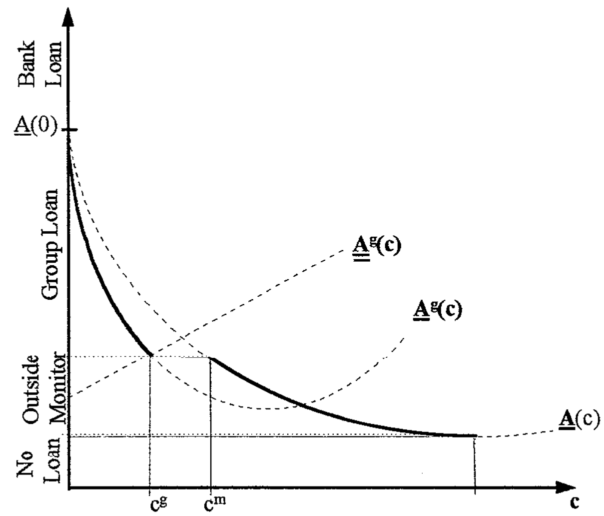
With identical monitoring technology, group loans are always dominated by simpler lender-intermediary loans

FIGURE 5.

available collateral asset level A to have resources to meet this second collateral requirement ($I^m(1+\rho)$ in the expression). After a point, as monitoring intensity c is increased, this second collateral requirement starts to rise more rapidly than the first one falls because of the diminishing returns to monitoring. It should be clear that if they share the same monitoring $B(c)$ then intermediary lending will also have a lower absolute minimum collateral requirement and hence be able to reach down to serve poorer borrowers. This is depicted in figure 5 by the fact that the curve $\underline{A}^g(c)$ turns up before the curve $\underline{A}(c)$ does.

As described in further detail below and in the appendix, the contract must also satisfy a constraint which prevents the borrowers from colluding to choose an action and monitoring sequence that is different from the one the lender intends to implement. This constraint is represented graphically by the rising diagonal line $\underline{\underline{A}}^g(c)$ in figures 5 and 6. Only points along the solid portion of the line $\underline{A}^g(c)$ and above $\underline{\underline{A}}^g(c)$ satisfy all the constraints on the contract.

In many circumstances it is reasonable to assume however that the members of a group possess information and enforcement mechanisms that place them at an advantage relative to an outside intermediary. Using (12) it is easy to see that there may be gains to using a group loan so long as the group monitoring technology $B^g(c)$ satisfies $B^g(c) < B(c) - \frac{\pi}{\overline{\pi}}c$. Figure 6 draws a situation where this condition is satisfied. As indicated in this figure, borrowers with collateral assets $A \in (\underline{A}(0), A^g(c_g))$



When group members have a much better monitoring technology group loans may,over a range, dominate lender-intermediary loans

FIGURE 6.

will prefer a loan through a group loan contract over a monitored loan by an outside intermediary because it is cheaper over this range.

As drawn in the figure, group loan contracts become infeasible for borrowers with assets below $A(c_g)$ because the cost of providing incentives to participate in group activities simply rises too fast. Borrowers with assets below this range will instead turn to moneylenders or to other monitoring intermediaries. This result can also be interpreted as saying that very poor borrowers are not likely to be selected into joint liability groups, and, instead will obtain finance from moneylenders and other informal sources. As in the previous section, the very poorest borrowers will be excluded from the credit market entirely unless they request very small loans. Many other situations could be constructed by making alternative assumptions on $B^g(c)$.

When comparing group arrangements to alternative lending arrangements we must bear in mind that the total cost of funds to the borrower includes the cost of participation in group activities and not just the monetary cost of funds. As the following remark makes clear, just because a group loan asks for lower monetary repayments (e.g. what appears to be a low or subsidized interest rate relative to other informal sources), does not mean it will always be preferred to other types of lending. The expected value of monetary repayments received by the outside lender in the case of a group loan is given simply by the bank rate $I(1+\rho)$ while for the intermediated loan it is $I(1+\rho)+c(A)$. In either case, net of monitoring costs the outside lender earns $(1+\rho)$ on each dollar invested.

Several final remarks on the structure of the problem and the proposed solution are in order. The first concerns the subject of collusion among group members. In addition to the concern of making sure that the contract provide individualized incentives to each group member, we must also take care that the members in the group do not discover that it is in their interest to collude to coordinate their actions and choose a course of action that is prejudicial to the outside lender. As shown in more detail in the appendix, this problem arises because there are in general a multiplicity of Nash equilibria that any given contract can implement (see also Mookerjee (1984)) To avoid this from the contract must be designed so that the agents obtain a higher payoff from choosing the intended equilibrium. This requirement of course imposes additional constraints on the problem and therefore can only further reduce the feasible contracting region. In this model, the no collusion constraint requires that the group members receive a higher payoff from the optimal monitoring, high action sequence relative to another zero monitoring, low action equilibrium. This constraint leads to the diagonal line $\underline{\underline{A}}^g(c)$ in figures 5 and 6.

In a joint liability contract each borrower in a sense divests himself of part of his own project in order to acquire a stake in the other borrower's project by becoming a monitor/cosignor. Each member is left with a safer, more diversified portfolio of projects which calls for a lower collateral requirement. The ability of the group to create social collateral, so to speak, rests on a version of the collateral diversification effect identified by Diamond (1984) and which has formed the basis for many results in the agency contracting literature. The economic principle is this: the total collateral requirement on two less than perfectly correlated projects will in general be set lower than on two perfectly correlated projects (or one single project twice the scale) because by funding two projects simultaneously the lender is in a sense allowing the borrower to pledge the expected returns from one project for the missing collateral for the other project and vice-versa. A successful project outcome from one project can cover the losses from a potential failure on the other project so the lender has effectively increased the expected returns he can capture in the failure state on any given project without increasing the physical collateral requirement. This of course also increases the incentives for the borrower to work to raise the probability of success on each project because where he previously lost only his limited physical collateral assets for failure on any one project he now risks losing the positive returns he might have earned on other projects.

It is important to note that much of the scope that exists for making joint liability loans work depends in a crucial way on the assumed timing of the game. As is common in the literature on monitored lending and hiearchical agency structures, I have assumed that the monitoring action that the monitor/supervisor takes to modify the (other) borrower's goals are chosen and set in place prior to the borrower's choice of productive action. Any threatened or implied sanctions that might form part of this monitoring strategy are therefore assumed to be credibly known to the borrower to whom they are directed. This assumption seems reasonable enough in many circumstances, given the way that many of these loans are implemented, but it also serves to highlight and underscore these practices. For instance, the extent of each group member's joint liability must be clearly and credibly established when the contract is offered, and many of the activities associated with monitoring and sanctioning such as attending group meetings, making visits to the other borrower's project, etc. are programed to take place ahead of the time the borrower chooses all his production actions or contemplates diverting funds. As the following loosely stated remark makes clear, the possibilities of group lending change dramatically under the alternative assumption that monitoring and productive action strategies are chosen simultaneously:

Remark 4.1. *If the structure of the game is modified so that each borrower-cum-monitor chooses his monitoring and productive activity actions simultaneously rather than sequentially, then the scope for creating social collateral through peer-monitoring collapses.*

This result is reminiscent of the strong negative result obtained by Itoh (1991) that teamwork will only be optimal under the assumption that the marginal disutility of monitoring effort is zero at zero monitoring. To see why this remark is true: assume otherwise, in other words assume that a group contract exists which implements the symmetric action pair. Since this is the assumed Nash equilibrium outcome, $(\overline{\pi}, c)$ must be a symmetric best response. But it is easy to see that this cannot in fact be the case because borrower One will reason that his best response to $(\overline{\pi}, c)$ is in fact $(\overline{\pi}, 0)$; given that borrower two will choose the high action borrower one can only gain by economizing on the costly monitoring activity c. But borrower two will then reason that his best response to borrower One's $(\overline{\pi}, 0)$ is $(\underline{\pi}, 0)$,[13] which in turn leads borrower one to change to $(\underline{\pi}, 0)$. And so the only symmetric equilibrium action-monitoring strategy of the game is $(\underline{\pi}, 0)$.

My analysis therefore shows a way out from Itoh's dilemma and points to another delicate aspect of the design of group contracts. One should conclude that it is not enough to simply create a joint liability contract to induce peer monitoring, but that the contract must also rely on a particular timing sequence and/or a commitment technology.

Finally, note that the derived optimal contract has a rather extreme shape that loads all rewards to the borrower on the joint outcome x_{ss}. This type of contract is known as a "live or die contract," is in general the optimal contract where agents are risk neutral and are subject to limited liability. As argued by Innes (1990) and Conning (1995) however, when additional monotonicity constraints are imposed on

[13] I am assuming here that the borrowers considered do not have enough collateral to credibly commit to implementing the high action a_h under individualized loan contracts.

the problem (constraints which can be justified on the grounds of no arbitrage across contracts), the optimal contract for risk neutral borrowers becomes a standard debt contract.[14] The basic trade-offs involved in a group loan contract will not change by introducing this additional structure, and the optimal contract would still involve joint liability although, clearly, the scope for lowering collateral requirements will in general reduced whenever new constraints are imposed.

5. Conclusion

Much of the physical and legal institutional infrastructure which sustains and enforces economic transactions and that is taken for granted in more affluent and developed areas is often either imperfectly established or entirely missing in poorer areas, developing countries, and economies in transition. In such circumstances lenders often find that it is simply unprofitable to lend to small and poor borrowers without additional collateral guarantees, even when they are free to charge any interest rate they want to recover their monitoring and enforcement expenses. The problem is not that there are no working institutions in these environments. One often discovers in fact a very rich set of local institutions, customs and kinship ties that serve to define and enforce social and economic interaction, and often quite efficiently. The problem is rather that outsiders who might be able to bring trade and finance opportunities find that it is difficult and costly to enter, understand, and participate within these local institutions, and therefore simply opt to stay out. If the poor are to have a fair chance to build upon their energies and abilities rather than be limited by their own initial wealth position, what is needed are effective intermediary institutions and contractual arrangements that build bridges to outside opportunities for credit and trade but which respect and harness the rich existing information and informal sanctions base that already exists within these communities.

The simple model I have presented in this paper has analyzed one important mechanisms which explains how such lofty sounding ideas might be, and have been implemented, but which also serves to highlight some of the difficulties, trade-offs and hidden costs involved.

There are several directions in which this research might be extended. Allowing the analysis by allowing the borrowers continuous action choice sets and more importantly allowing multiple project outcomes is not likely to add much in the way of new insight but would require a substantially more technical analysis.[15] The virtue of working

[14] Very loosely, monotonicity constraints require that the repayment due to a lender be nondecreasing in the size of the project outcomes. Note that monotonicity constraints impose significantly less structure on the contract than the sort of linearity assumptions more commonly imposed in the literature.

[15] If borrowers could choose actions from a continous set, the borrower's private benefit function for a given action choice a and monitoring intensity c could be denoted $B(a, c)$. A positive cross partial term $B_{ac} > 0$ would indicate that the monitoring/helping activity c raises the marginal

with a simpler model is not only that it often affords clearer intuitions, but also that it allows us to solve for the exact terms of the contract and see how these respond to changes in the model's parameters. This approach is especially useful when considering problems with limited liability constraints because such problems are not readily analyzed using many of the standard tools of marginal analysis and the first order approach commonly employed in the agency literature (Grossman and Hart, 1983).

The problem analyzed here would be complicated in interesting ways by introducing risk averse borrowers and at the same time allowing a more general correlation structure in the borrower's project returns. Several complimentary and offsetting forces would then come into play to shape the final optimal contract. On the one hand the contract might want to encourage monitoring interaction among the members through joint liability contracts for the reasons analyzed here and by Itoh (1991). To harness this effect, the contract would in general make each borrower's reward an *increasing* function of the measured performance of other borrowers in the group. If however there is sufficient correlation structure in project outcomes, the contract may also want to link the reward due to one borrower to the performance of other borrowers for the reasons identified in the the relative performance evaluation (RPE) literature. Most of these analyses have examined contracts that work in the opposite direction from the joint liability structure outlined here: each borrower's reward is made to be a *decreasing* function of the other borrower's measured performance. As Itoh (1991) points out however there are situations where the reverse can also be optimal for RPE.

While RPE-type contracts may be beneficial for risk sharing reasons, the incentive structure they create might at the same time encourage agents to sabotage and hamper each other's performance. While these two effects will typically be in conflict, in a somewhat more general setting a lender might be able to design a structure that involves elements from both types of contract. For instance the lender might group borrowers into small borrowing circles within which joint liability incentives to encourage peer-monitoring is applied but at the same time utilize a relative performance evaluation structure between groups. The group's reward (for instance how much leniency or loan forgiveness the lender allows in response to failed project outcomes) will depend on the performance of other groups in the lending scheme.

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return to higher productive actions a, and the principal will in general want to create incentives for the agents to cooperate. Contrarywise, when $B_{ac} < 0$ one agent's action c, gets in the way or sabotages the other agent's production choice and the principal will in general want to dissuade interaction.

Appendix A. Appendix

For the proof below it will be useful to know, for a given contract s, how the payoffs, and hence the equilibrium outcome of the subgame in action choices changes in response to the monitoring choices made at the first stage of the game. The following functions summarize the payoff in each of the four cells of subgame $\zeta(c, c')$:

$$\begin{aligned} &HH(c') : E(s_{ij}|\overline{\pi}, \overline{\pi}) - c \\ &LH(c') : E(s_{ij}|\underline{\pi}, \overline{\pi}) - c + B(c') \\ &HL(c') : E(s_{ij}|\overline{\pi}, \underline{\pi}) - c \\ &LL(c') : E(s_{ij}|\underline{\pi}, \underline{\pi}) - c + B(c') \end{aligned} \tag{13}$$

For example, $LH(c')$ indicates the payoff to borrower one (two) when he chooses the low action $\underline{\pi}$ and monitors the other borrower at intensity c and he is in turn monitored at intensity c' and the other borrower chooses the high action $\overline{\pi}$. Figure 7 draws these graphs as a function of c'. Note that the the vertical intercepts will in general depend on the terms of the offered contract – the figure is drawn for the proposed optimal contract as explained below.

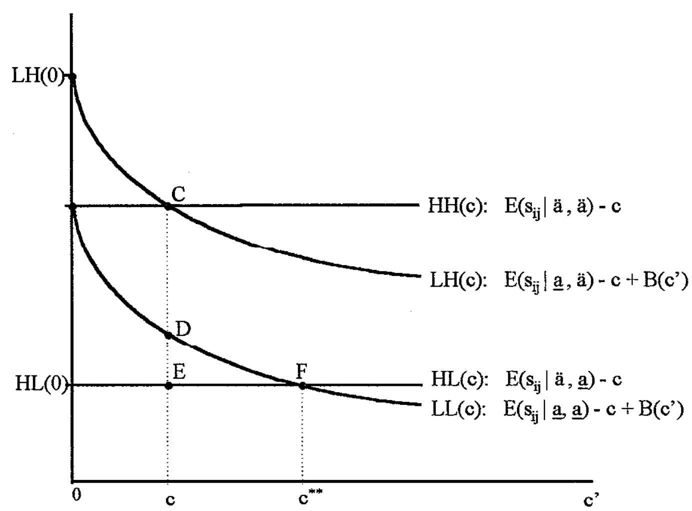

Figure 7. Payoff to Borrower One when Borrower Two monitors at c'

Proof of Proposition 4.1 :

To show that the proposed contract s_{ij} is optimal I must show that at the induced subgame perfect Nash equilibrium (SPNE) of the game each borrower chooses the action pairs $(\overline{\pi}, c)$ (where $c = c(A)$ is defined as in the proposition) and that this solution cannot be improved (i.e. that monitoring expense is at a minimum). For $(\overline{\pi}, \overline{\pi})$ to be the Nash equilibrium of the subgame $\zeta(c, c)$ then $\overline{\pi}$ must be a best response to $\overline{\pi}$ and vice-versa. This requires that the following incentive compatibility constraint be met:

$$HH(c,c) \geq LH(c,c) \tag{14}$$

Writing out this inequality using the proposed solution structure and rearranging yields:

$$\begin{gathered} \overline{\pi} Z(c) - \underline{A}^g(c) - c \geq \overline{\pi}\underline{\pi} Z(c) - \underline{A}^g(c) + B(c) \\ Z(c) \geq \tfrac{B(c)+c}{\overline{\pi}\Delta\pi} \end{gathered}$$

where as before $\Delta\pi = (\overline{\pi} - \underline{\pi})$. Substituting this expression into the investor's binding participation constraint we get[16]

$$E(R_{ij}|\overline{\pi}, \overline{\pi}) = E(x|\overline{\pi}) - E(s_{ij}|\overline{\pi}, \overline{\pi}) = I(1+\rho)$$

which allows us to find an expression for the minimum collateral requirement at which this condition is met and the investor just breaks even:

$$\begin{gathered} E(x|\overline{\pi}) - (\overline{\pi})^2 Z(c) + \underline{A}^g(c) = I(1+\rho) \\ \underline{A}^g(c) = \overline{\pi}\tfrac{B(c)+c}{\Delta\pi} - E(x|\overline{\pi}) + I(1+\rho) \end{gathered}$$

This is expression (10) in the proposition.

Several other constraints must be met to assure that the required symmetric monitoring intensity $c(A)$ is sustained as a Nash equilibrium at the first stage. As will become clear we need be concerned primarily with the condition that the borrowers in the group get a higher payoff from monitoring at intensity $c(A)$ than from abandoning monitoring altogether. This can be interpreted as the borrowers in the group colluding against the lender by accepting a contract but then together choosing zero monitoring and the low input choice $\underline{\pi}$. No collusion requires that:

$$\begin{aligned} HH(c,c) &\geq LL(0,0) \\ E(s_{ij}|\overline{\pi}, \overline{\pi}) - c &\geq E(s_{ij}|\underline{\pi}, \underline{\pi}) + B(0) \end{aligned} \tag{15}$$

[16]We are using the additive separability of the investor's participation constraint and the symmetry in the repayments received from each farmer to express the investor's constraint only in terms of farmer one.

Writing this inequality out in full

$$\begin{gathered}\overline{\pi}s_{ss}+\overline{\pi}(1-\overline{\pi})s_{sf}+(1-\overline{\pi})\overline{\pi}s_{fs}+(1-\overline{\pi})^2s_{ff}-c\geq\\ \underline{\pi}s_{ss}+\underline{\pi}(1-\underline{\pi})s_{sf}+(1-\underline{\pi})\underline{\pi}s_{fs}+(1-\underline{\pi})^2s_{ff}+B(0)\end{gathered}$$

A little thought reveals that this constraint can be met at minimum collateral expense by using a contract that places as much of the rewards as possible to the borrower on s_{ss} and sets the other s_{ij} as full payments out of collateral (Conning, 1995; Innes, 1990). This is the diversification effect that makes group loans work and the key for understanding the rather extreme structure of the proposed solution.[17] Substituting a contract of the proposed shape into expression (15) above yields:

$$\begin{gathered}\overline{\pi}^2Z(c)-\underline{A}^g(c)-c\geq(\underline{\pi})^2Z(c)-\underline{A}^g(c)+B(0)\\ Z(c)\geq\frac{B(0)+c}{\overline{\pi}^2-\underline{\pi}^2}\end{gathered}$$

which, after substitution into the investor's participation constraint requires that the minimum collateral requirement meet the following restriction:

$$\underline{A}^g(c)\geq\overline{\pi}\left[\frac{B(0)+c}{\overline{\pi}^2-\underline{\pi}^2}\right]-E(x|\overline{\pi})+I(1+\rho)=\underline{\underline{A}}^g(c)$$

which is expression (11). In figure 6 the locus of points above the rising diagonal line $\underline{\underline{A}}^g(c)$ satisfy this relationship. Note that as drawn in figure 7, $HH(0)=LL(0)$ so constraint (15) is met exactly.

We are now in a position to analyze the equilibria of the different subgames to trace out the equilibrium game play. Consider first the subgame $\zeta(c,c)$. It has two symmetric Nash equilibria: $(\overline{\pi},\overline{\pi})$ and $(\underline{\pi},\underline{\pi})$ but the first gives a higher payoff to both borrowers. The first equilibrium is evident because by construction the contract satisfies $HH(c)\geq LH(c)$. To see that $(\underline{\pi},\underline{\pi})$ is also an equilibrium notice that at any given c' the fixed vertical distance between $HH(c')$ and $HL(c')$ is larger than the fixed vertical distance between $LH(c)$ and $LL(c)$,[18] so given the no collusion constraint $HH(c)\geq LL(0)$, the graph of $HL(c)$ and $LL(c)$ will always intersect at some point c^{**} to the right of the monitoring intensity c that we wish to implement. This in turn implies that $LL(c)>HL(c)$ as indicated by point D being located above point E in the figure, so $\underline{\pi}$ is in fact a best response to $\underline{\pi}$ and vice-versa. It is natural to assume that the borrowers coordinate on the first equilibrium because $HH(c)>LL(c)$.

[17] Because placing rewards on the single signal x_{ss} provides the strongest signal that the borrower cum monitor has chosen $\overline{a}$ and c. It is easy to show that this is always the case for $p_h>p_l>\frac{1}{3}$. For a more detailed discussion see Conning (1995).

[18] Proof: Assume not. Then $HH(c)-HL(c)\leq LH(c)-LL(c)$. Writing out the terms for this expression at the proposed contract and simplifying leads to the expression $p_hZ(c)\leq p_lZ(c)$, a contradiction since by assumption $p_h>p_l$.

Consider now subgame $\zeta(0, c)$ and equivalently, $\zeta(c, 0)$. $(\overline{\pi}, \overline{\pi})$ cannot be a Nash equilibrium of that subgame because $LH(0) \geq HH(0)$ so borrower two will choose $\underline{\pi}$ as a best response to $\overline{\pi}$. But borrower one will in turn choose $\underline{\pi}$ as a best response to $\underline{\pi}$ because $LL(c) > HL(c)$. Since borrower two will choose $\underline{\pi}$ as a best response to borrower one's $\underline{\pi}$ because $LL(0) > HL(0)$, $(\overline{\pi}, \overline{\pi})$ is the unique Nash equilibrium of these games. Moving back in the game tree, since the equilibrium payoff $HH(c)$ to borrower one from subgame $\zeta(c, c)$ is higher than the equilibrium payoff $LL(c)$ from subgame $\zeta(0, c)$ it is evident that c is a best response to c at the first stage.

Consider finally the subgame $\zeta(0, 0)$. It is evident that $HH(0) < LH(0)$ so $(\overline{\pi}, \overline{\pi})$ cannot be a Nash equilibrium of that subgame. On the other hand $\underline{\pi}$ is a best response to $\underline{\pi}$ and vice-versa because $LL(0) < HL(0)$. Therefore (π, π) is the unique symmetric Nash outcome of the subgame. Moving back in the game tree it is clear that borrower one will choose monitoring intensity zero as a best response to borrower two's zero monitoring choice.

Both (c, c) and $(0, 0)$ are therefore Nash equilibrium of the game in monitoring intensities, but by the no collusion constraint (15) the symmetric payoff to the two borrowers is at least as high from choosing (c, c) as it is from choosing $(0, 0)$ so the borrowers will choose the former and $\{(\overline{\pi}, c), (\overline{\pi}, c)\}$ emerges as the choosen subgame perfect Nash equilibrium of the overall game.

To see that the proposed solution minimizes on monitoring costs note that the borrower's overall return $E(s_i|\overline{\pi}, \overline{\pi}) = E(x|\overline{\pi}) + I(1 + \rho) - c$ will be maximized when monitoring intensity is at a minimum. The minimum monitoring intensity is obtained when the borrower uses all of his available collateral resources, at $A = A^g(c)$, which is the value used in the proposed optimal contract.

A last step is to check whether there are in fact any gains to monitoring within a group, in other words whether the first dollar spent on monitoring reduces the collateral requirement or whether $\frac{dA^g(c)}{dc}|_{c=0} < 0$. This condition simplifies to $B_c(0) < -\frac{1}{\overline{\pi}}$, the condition stated at the outset of Proposition. ■

REFERENCES

1. Adams, D. and J.R. Landman (1979) "Lending to the Poor Through Informal Groups: A Promising Financial Innovation?" *Savings and Development*, 2 85-94.
2. Arnott, R. and J.E. Stiglitz (1991) "Moral Hazard and Non-Market Institutions: Dysfunctional Crowding Out or Peer Monitoring?" *American Economic Review*
3. Banerjee, A., Besley, T., and Guinnane, T. (1994) "Thy Neighbor's Keepper: The Design of a Credit Cooperative with Theory and a Test," *Quarterly Journal of Economics*.
4. Besley, T. and Coate, S. (1995) "Group Lending, Repayment Incentives and Social Collateral,". *Journal of Development Economics*
5. Braverman, A. and T.N. Srinivasan (1980) Ïnterlinked Credit and Tenancy Markets in Rural Economies of Developing Countries, "World Bank Development Research Center, Washington, DC.

6. Braverman, A. and J.E. Stiglitz (1982) "Sharecropping and the Interlinking of Agrarian Markets, " *American Economic Review*, 72, 695-715.
7. Conning, J. (1995) "An Applied Theory and Empirical Investigation of Monitored and Peer-Monitored Lending: Rural Credit Markets in Chile," draft, doctoral dissertation, Department of Economics, Yale University, New Haven.
8. Conning, J. (1993) "The Political Economy of Agrarian Contract Choice," paper presented at the Yale Agrarian Studies Colloquium, April.
9. Cornes, R. and T. Sandler (1986) *The Theory of Externalities, Public Goods, and Club Goods*, Cambridge University Press, New York.
10. Diamond, D. (1984) "Financial Intermediation and Delegated Monitoring, "*Review of Economic Studies*, 51.
11. Guinnane, T (1994) "A Failed Institutional Transplant: Riaffeisen's Credit Cooperatives in Ireland, 1894-1914," *Explorations in Economic History*, 31, 38-61.
12. Holmstrom, B. and J. Tirole (1994) "Financial Intermediation, Loanable Funds and the Real Sector," mimeo.
13. Holmstrom, B. and P. Milgrom (1991) "Multitas Principal-Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design," *Journal of Law, Economics, and Organization*, vol 7 (sp), 24-52.
14. Holmstrom, B. and P. Milgrom (1990) "Regulating Trade Among Agents," *Journal of Institutional and Theoretical Economics*, 146: 85-105.
15. Holmstrom, B. (1982) "Moral Hazard in Teams," *Bell Journal of Economics*, 13, 324-340.
16. Hoshi, T. Kayshap, A. and D. Scharfstein (1992) "The Choice Between Public and Private Debt: An Analysis of Post-Deregulation Corporate Financing in Japan," mimeo.
17. Hossain, M. (1988) *Credit for Alleviation of Rural Poverty: The Grameen Bank in Bangladesh*, Research Report 65. International Food Policy Research Institute, Washington, DC.
18. Huppi, M. and G. Feder (1990) "The Role of Groups and Credit Cooperatives in Rural Lending, *World Bank Research Observer*, 5, 187-204.
19. Itoh, H. (1993) "Coalitions, Incentives, and Risk Sharing," *Journal of Economic Theory*, 60: 410-427.
20. Itoh, H (1992) "Cooperation in hiearchical organizations: An incentive perspective," *Journal of Law Economics and Organization*, 8, 321-345.
21. Itoh, H. (1991) "Incentives to help in multi-agent situations," *Econometrica*, 59,611-636..
22. Lazear, E. and Kandel, E. (1992) "Peer Pressure and Partnerships, "*Journal of Political Economy*, 100(4), 801-817.
23. Mookerjee, D. (1984) "Optimal incentive schemes with many agents," *Review of Economic Studies*, 51,433-446.
24. Olson. M. (1965) *The Logic of Collective Action: Public Goods and the Theory of Collective Action*, Harvard University Press, Cambridge, MA.
25. Pitt, M. and S. Khandler (1995) "Household and Intra-Household Impacts of the Grameen Bank and Similar Targeted Credit Programs in Bangladesh," World Bank/BIDS. March.
26. Stiglitz, J. (1990) "Peer Monitoring and Credit Markets," *World Bank Economic Review*, 4, 351-366.
27. Tirole, J (1993) "Collusion and the Theory of Organization," In Laffont, ed. *Advances in Economic Theory*, .
28. Varian, Hal (1990) "Monitoring Agents with Other Agents," *Journal of Institutional and Theoretical Economics* 146:153-74.